

## Background

Traits in humans are often difficult to study for several reasons. Unlike fruit flies, which produce large numbers of offspring very quickly, humans reproduce slowly and usually produce only one offspring at a time. So traits in humans must be studied through *population sampling* and *pedigree analysis*. In this activity, pedigree analysis is used to study human traits.

A pedigree shows a family's pattern of inheritance for a specific trait. In a pedigree each person is assigned a number and each generation is represented by a *Roman numeral*. Therefore, each person is identified by a Roman numeral and a number. Females are represented by *circles* and males by *squares*. *Shaded symbols* indicate individuals who have the trait in question. (*Note: Shaded symbols do not always indicate recessiveness; if the trait being studied is dominant, those who are dominant will be shaded.*) In some pedigrees, if a person is heterozygous (a carrier) for a trait, the symbols are half shaded. In many cases, by studying a family's pedigree, the genotypes of most, if not all, of the members can be determined.

## Materials

Pedigree Analysis Worksheet

Pencil

## Safety

There are no particular safety concerns for this activity, but follow all normal laboratory safety rules.

## Procedure

Follow the directions on the Pedigree Analysis Worksheet.

**Pedigree Analysis Worksheet**

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**Part A**

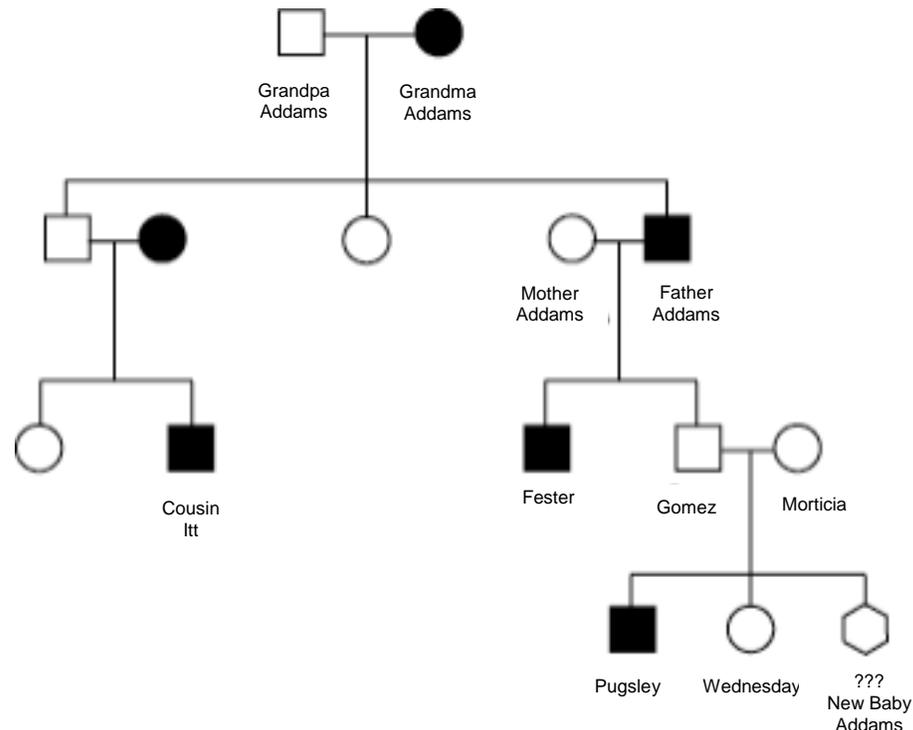
*Gomez and Morticia Addams are expecting a new baby! They have come to your genetic counseling firm to find out the probability that it will have webbed feet, a trait that runs in the family.*

1. Observe the following pedigree. Number the generations and each person on the pedigree.
2. Determine the genotypes of the individuals in the pedigree wherever possible. Write the genotypes on the pedigree.
3. Determine the probability that new baby Addams will have webbed feet.

The Addams Family Pedigree for Webbed Feet

B = normal feet

b = webbed feet



**Part B**

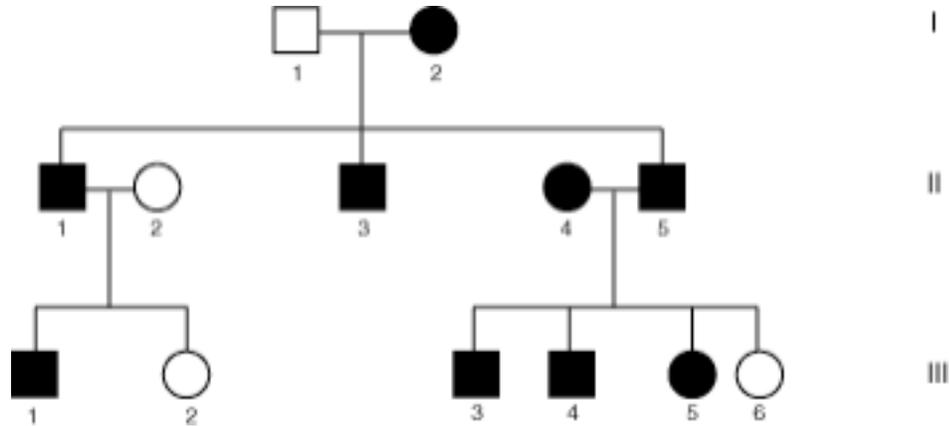
1. Draw the following pedigree. Albinism is a recessive trait.

“One couple has a son and daughter with normal pigmentation and a son that is an albino. Another couple has one son and two daughters with normal pigmentation. The daughter from the first couple has three children with the son of the second couple. Their son and one daughter have albinism; their other daughter has normal pigmentation.”

2. Label the generations and each individual in the pedigree.
3. Determine the genotypes of as many individuals as possible.

### Part C

Observe the following pedigree for tongue-rolling.



Answer the following questions

1. The ability to roll the tongue into a U-shape is determined by a single gene. Determine if you can roll your tongue.  
yes \_\_\_\_\_ no \_\_\_\_\_
2. Do any of the children in generation II have the same phenotype as their father? If so, which ones?
3. In which generation do children appear with the same phenotype as individual I-1?
4. Individuals II-4 and II-5 have the same phenotype. Three of their children have the same phenotype, but one, III-6, does not. What genotypes must individuals II-4 and II-5 be to produce children with these phenotypes? Explain.
5. Is tongue-rolling a dominant or recessive trait? Explain.

## Teacher Notes

### Pedigree Analysis

#### Time Required

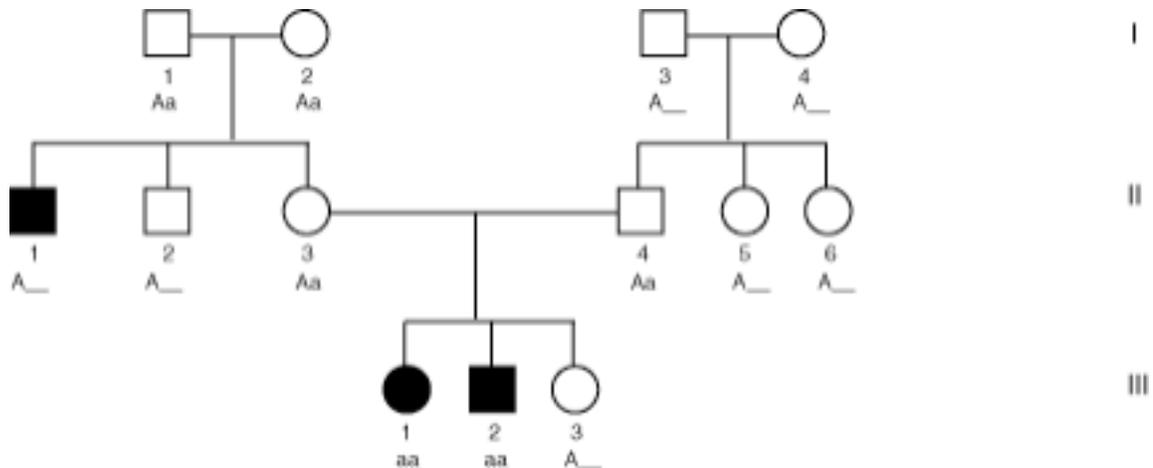
This activity can be completed in one 50-minute period.

#### Answers to Questions

##### Part A

2. All shaded individuals are  $bb$ . Individuals I-1, II-1, II-3, II-4, III-1, III-4, III-5 are heterozygous ( $Bb$ ), and Individual IV-2 can't be determined.
3. The probability that Baby Addams will have webbed feet is  $1/4$ . Gomez and Morticia must both be heterozygous to have a child with webbed feet (Pugsley). The probability that Gomez will contribute a "b" gene is  $1/2$  and the probability that Morticia will contribute a "b" gene is also  $1/2$ . The probability that they will both contribute their "b" gene is the product of their separate probabilities, or  $1/2 \times 1/2 = 1/4$ .

##### Part B



Since individuals II-3 and II-4 must both be heterozygous, they both must have received a recessive allele from one of their parents. Individuals I-1 and I-2 must both be heterozygous. But without further information, we cannot determine the genotypes of individuals I-3, I-4, II-2, II-5, or II-6.

##### Part C

1. Each student should determine for themselves if they can roll their tongue.
2. None of the children in generation II have the same phenotype as their father.
3. Individuals with the same phenotype as I-I appear in the third generation.
4. Individuals II-4 and II-5 must be heterozygous. They have one child that has a different phenotype than they do. If they were both recessive, all of their children would have to be recessive also.
5. Tongue-rolling must be dominant.

## Teacher Tips

- Make sure the students number the generations and each individual.
- The genotypes of some individuals can't be determined because they could be either homozygous dominant or heterozygous. The only way to tell is to wait until they have children of their own.
- Encourage students to do the math on paper when determining probabilities. It will help them to understand more complicated genetics problems later.
- In Part C, ask the class to raise their hands if they can roll their tongues. It will seem obvious that the trait is dominant. *Note:* This is not always the case, however. Type O blood is found in 40 percent of the population although the O allele is recessive.

## Safety/Disposal

There are no particular safety/disposal concerns for this activity, but follow all normal laboratory safety rules.

## Extensions

Have the students conduct their own experiment using PTC paper. Have them taste the paper and hypothesize whether it is a dominant or recessive trait. They can test further by recording the number of classmates that can and can't taste PTC. They can then take paper home and test their family members. From this, they can construct a family pedigree, and examine the pattern of inheritance.

Students can construct family pedigrees for a trait of their choice. Be sensitive to the fact that many students today come from blended or single-parent families. Some may also be adopted. Allow these students to do a pedigree on another family they know.